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(54) Title: COATED CEMENTED CARBIDE INSERT FOR METAL CUTTING APPLICATIONS

(57) Abstract

The present invention relates to coated inserts for metal cutting applications containing at least one hard constituent of a carbide, nitride and/or carbonitride of the metals Ti, Ta, Hf, Nb, V, Zr and W or solid solutions thereof, in 3-20 weight-%, preferably 4-14 weight-%, binder phase. By using a binder phase comprising in solid solution: Co max 95 %, Ni max 95 % and Cr 3-25 % improved properties are obtained particularly in machining operations of intermittent character. Coatings comprising carbides and/or carbonitrides and/or oxicarbides and/or oxinitrides and/or oxicarbonitrides of titanium and/or Al_2O_3 are particularly useful.

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Coated cemented carbide insert for metal cutting applications.

The present invention relates to coated cemented carbide inserts with improved cutting properties being obtained as a result of modifications of the chemical and mechanical properties of the binder phase.

Cemented carbide grades for metal cutting applications generally contain WC, γ-phase (a solid solution of generally TiC, NbC, TaC and WC) and binder phase, generally cobalt. Their properties are optimized by varying the WC grain size, volume fraction of the binder phase and/or the γ-phase and by optimising the carbon content. One recent major improvement of the properties of coated cemented carbide is the introduction of binder phase enriched surface zones.

Thus, two major groups of coated cemented carbide inserts for metal cutting are used today: one with even distribution of binder phase within the whole insert and one with binder phase enriched surface zones.

The cemented carbides with binder phase enriched surface zones are mainly found in γ-phase containing grades whereas straight WC-Co grades have even binder phase distribution without said binder phase enrichment.

In both these groups of cemented carbides the binder phase is based on cobalt containing varying amounts of tungsten and carbon in solid solution. In addition to tungsten or carbon, only very low contents of other elements (mainly impurities) are present in the binder phase.

In applications in highly corrosive environments e.g. wear parts in pumps, compressors or cutters in wood working industry ordinary WC-Co based cemented carbides fail due to corrosion attacks from various types of the corrosive media which react with and deteriorate the cobalt binder phase. In such applications binder phase

alloys based on Co-Ni-Cr or Ni-Cr are used e.g. such as disclosed in EP-A-28620.

Surprisingly it has now been found that by using a cemented carbide with a corrosion resistant binder phase large improvements in tool life are achieved for coated cemented carbides in certain metal cutting operations.

The invention relates to a coated cemented carbide for metal cutting applications. Said cemented carbide contains 3-20 weight-%, preferably 4-14 weight-% binder phase comprising in solid solution in weight-%: Co max 95, Ni max 95, Cr 3-25, preferably 5-15, and, optionally, W max 30, Mo max 15, Al max 2 and Fe max 70.

In a preferred embodiment the binder phase comprises in solid solution in weight-%: Co 20-80, Mo 1-6, preferably about 2, Cr 3-15, preferably about 10 and rest Ni. V may be added up to 5 weight-%, preferably between 1 and 3 weight-%.

In yet a preferred embodiment the binder phase is nickel based and comprises in solid solution , in weight-%: Co max 30, Mo 1-6 and Cr 3-15.

In still a preferred embodiment the Co:Ni weight ratio in the binder phase is about 1:1 or about 3:1.

The carbon content should be between a lower value corresponding to the η-phase limit and an upper value corresponding to the stoichiometric carbon content. In certain embodiments the carbon content can be below the η-phase limit and thus the cemented carbide will contain also η-phase or other substoichiometric phases. 1-20 volume-% has been found suitable, preferably 3-10 volume-%.

At too high carbon or chromium contents the brittle chromium carbide is formed and, thus, both chromium and carbon contents must be selected so that the formation of chromium carbide is kept at a minimum.

The invention can be applied to inserts with even distribution of binder phase or, preferably, to inserts with a binder phase enriched surface zone up to 50 µm, preferably between 10 and 25 µm thick. The degree of the binder phase enrichment shall be between 1.2 and 2.5 times, preferably between 1.4 and 1.8, higher than the binder phase content of the rest of the insert. Such inserts can be made e.g. using the technique disclosed in US 4,610,931.

The cemented carbide is coated with wear resistant layers as known in the art using known CVD, MTCVD or PVD technique. MTCVD is a moderate temperature CVD-process using e.g. CH_3CN gas and $TiCl_4$. If the total nickel content is more than about 1.5 weight-% care has to be taken to avoid the detrimental effects of nickel on the coating quality e.g. by using at least at the beginning of the coating process a rather low temperature, preferably <960 °C.

Coatings comprising carbides and/or carbonitrides and/or oxicarbides and/or oxinitrides and/or oxicarbonitrides of titanium and/or Al_2O_3 are particularly useful. In a preferred embodiment at least one 0.3-5 µm, preferably 0.5-1.5 µm, interlayer comprising Ti(C,O) or Ti(C,O,N) or Ti(N,O) is deposited within a part of the coating containing titanium about 0.5-3 µm from the cemented carbide surface such as disclosed in Swedish Patent Application 9400951-1.

The coating thickness shall be <30 µm, preferably 3-16 µm. For milling applications the total coating thickness should be 3-7 µm and for turning applications the total coating thickness should be 5-16 µm.

The present invention is particularly useful in machining of steel and cast iron when the cutting inserts are subjected to thermal and mechanical fatigue conditions. This is typical for milling operations but some-

times it also occurs in certain turning operations with intermittent character.

The reason for the observed tool life for the coated cemented carbide according to the present invention is still not understood in detail. It is believed that through the cracks already present in the coating, or formed during the cutting within the cemented carbide or the coating, the binder phase is oxidised causing weakening of the areas close to the coating. By use of the more oxidation resistant binder phase compositions this type of drawback is largely decreased. The chromium addition increases the binder phase oxidation resistance. However, addition of nickel both increases the oxidation resistance of the cobalt binder phase but also decreases the deformation hardening by stabilization of the FCC-structure of the cobalt phase.

The invention has been described with reference to cutting tool inserts of cemented carbide. It is obvious that the invention can be applied to coated cutting tool insert for metal cutting applications containing at least one hard constituent of a carbide, nitride and/or carbonitride of the metals Ti, Ta, Hf, Nb, V, Zr and W or solid solutions thereof in a binder phase.

Example 1

Cutting tool inserts according to the invention with the following composition in weight-%: 91.5 WC, 3.9 Co, 3.7 Ni, 0.8 Cr, 0.1 Mo were prepared and coated with a coating consisting of 0.5 µm TiN, 5 µm Ti(C,N) and 3 µm Al_2O_3. The TiN layer was the inner layer closest to the cemented carbide and it was deposited at a temperature of 920 °C. The Ti(C,N) layer was deposited using MTCVD technique.

As reference, inserts with the composition in weight-%: 91.5 WC and 8.5 Co and provided with the same coating were used.

Cutting test:

50 inserts from each group were tested with the following conditions:

Operation: Face milling

Work piece: Pump house in grey cast iron (SS0125)

Cutting speed: 263 m/min

Feed rate: 0.14 mm/tooth

Depth of cut: 2 mm

Cutting fluid: Emulsion

Insert type: TNHF 1204AN-65

Tool life criterion: Edge frittering of the work piece.

Tool life:

Inserts according to the invention: 29 minutes

Reference inserts: 16 minutes

Example 2

Cutting tool inserts according to the invention with the following composition in weight-%: 94.5 WC, 3.3 Co, 1.1 Ni, 0.6 Cr, 0.1 Mo, 0.2 VC were prepared and coated with a coating consisting of: 1.5 µm TiC, 0.5 µm Ti(C,O), 7 µm Ti(C,N) and 6 µm Al_2O_3. The TiC layer was the innermost layer closest to the cemented carbide and the Al_2O_3 layer was the outermost layer.

As reference, inserts with the composition in weight-%: 94.7 WC and 5.3 Co and provided with the same coating were used.

Cutting test.

Operation: Facing with interrupted cuts

Work material: Ferritic-perlitic nodular cast iron (SS0727)

Cutting speed: 150 m/min

Feed rate: 0.1 mm/rev
Depth of cut: 2.0 mm
Cutting fluid: none
Insert type: CNMA 120412
Tool life criterion: Flank wear $\geq$ 0.3 mm
Tool life:
Inserts according to the invention: 75 min
Reference inserts: 41 min

Claims

1. Coated insert for metal cutting applications containing at least one hard constituent of a carbide, nitride and/or carbonitride of the metals Ti, Ta, Hf, Nb, V, Zr and W or solid solutions thereof in 3-20 weight-%, preferably 4-14 weight-%, binder phase c h a r a c t e r i s e d in that the binder phase contains in solid solution the following elements in weight-%: Co max 95, Ni max 95, Cr 3-25.

2. Coated insert according to the preceding claim c h a r a c t e r i s e d in that the binder phase in addition contains W max 30, Mo max 15, Al max 2 and Fe max 70.

3. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in that the binder phase comprises in solid solution, in weight-%: Co 20-80, Mo 1-6, preferably about 2, Cr 3-15, preferably about 10 and rest Ni.

4. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in that the binder phase comprises in solid solution , in weight-%: V up to 5 weight-%, preferably about 4 weight-% may be added.

5. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in that the binder phase is nickel based and comprises in solid solution , in weight-%: Co max 30, Mo 1-6 and Cr 3-15.

6. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in that the Co:Ni weight ratio in the binder phase is about 1:1 or about 3:1.

7. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in an up to 50 µm thick binder phase enriched surface zone.

8. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in containing 1-20 volume-% η-phase or other substoichiometric phase.

9. Coated insert according to any of the preceding claims c h a r a c t e r i s e d in a coating comprising carbides and/or carbonitrides and/or oxicarbides and/or oxinitrides of titanium and/or -oxicarbonitrides and/or Al_2O_3.

10. Coated insert according to claim 9 c h a r a c t e r i s e d in at least one 0.3-5 µm, preferably 0.5-1.5 µm, interlayer comprising Ti(C,O), Ti(C,O,N) or Ti(N,O) within a part of the coating containing titanium about 0.5-3 µm from the insert surface.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 95/01516

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: C23C 30/00, C04B 41/87, B23B 27/14
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: C23C, C04B, B23B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	--	1-3,5-10
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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